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WHEAT LEAF RUST STUDIES AT SAINT PAUL, MINNESOTA

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The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Division of Mycology and Disease Survey serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

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PLANT DISEASE REPORTER SUPPLEMENT

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THE PLANT DISEASE SURVEY
DIVISION OF MYCOLOGY AND DISEASE SURVEY

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WHEAT LEAF RUST STUDIES AT SAINT PAUL, MINNESOTA[1]

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Plant Disease Reporter
Supplement 199 March 30, 1951

This report is presented in response to a recommendation adopted at the Eighth Hard Red Spring Wheat Conference, held at Saint Paul, Minnesota, on February 3-4, 1948. Three lines of investigations are summarized, viz.: (1) The occurrence and distribution of physiologic races isolated from wheat leaf rust specimens, collected in the Upper Midwest area of the United States during the 25-year period, 1925-1949, inclusive; (2) the seedling reaction of more than a hundred varieties of wheat to different physiologic races of Puccinia rubigo-vera tritici, tested under greenhouse conditions; and (3) the comparative reaction of some six dozen wheat varieties, grown in field plots at University Farm during one or more of the 10 years from 1938 to 1947, inclusive. No field notes were taken in 1948 and 1949, because of the virtual absence of leaf rust in the plots.

PHYSIOLOGIC RACES OF PUCCINIA RUBIGO-VERA TRITICI IN THE UPPER MIDWEST

Identification of wheat leaf rust races at St. Paul was started in 1925, the year leaf rust readings were begun in the cooperative uniform wheat nurseries maintained in different parts of the country. The number of isolates identified reached a substantial figure only during the past decade. As recorded in Table 1, a total of 1008 isolates were identified during the quarter century under review, averaging slightly over 40 identifications a year, but the average during the last quinquennium was somewhat in excess of 100 identifications per year. Of the four States involved in this study, Minnesota provided 59.2 percent of the isolates; North Dakota, 27.0 percent; South Dakota, 10.6 percent; and Montana, only 3.2 percent. Many persons, too numerous to mention by name, cooperated in the collection of uredial material in various parts of the area.

The isolates identified grouped themselves into 48 different physiologic races. The racial composition varied from year to year, to some extent, and from quinquennium to quinquennium, to a greater extent. Thus, while race 9 was predominant in its frequency of occurrence during the first three quinquennia, race 128 assumed the predominant position during the fourth quinquennium, but lost it to race 126 in the fifth. The five most common races during the entire quarter century were in the order listed: race 9 (10.7 percent), race 128 (10.4 percent), race 126 (8.8 percent), race 5 (8.7 percent), and race 15 (6.8 percent). Most common among the 44 races isolated from the Minnesota collections were race 128 (12.4 percent), race 126 (9.9 per-

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[1]Joint contribution from the Division of Agronomy and Plant Genetics and the Division of Plant Pathology and Botany, Department of Agriculture, University of Minnesota, in cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture. Published as Paper No. 2613 of the Scientific Journal Series of the Minnesota State Agricultural Experiment Station.

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Table 1. Physiologic races of Puccinia rubigo-vera tritici isolated from Upper Midwest

Physiologic races identified	Periodic and geographic distribution of physiologic races identified: Quinquennial periods									
	1925-1929		1930-1934		1935-1939		1940-1944		1945-1949	
	No.	%	No.	%	No.	%	No.	%	No.	%
1	-	--	2	4.9	-	--	5	1.4	22	4.2
2	-	--	-	--	-	--	9	2.5	6	1.1
3	4	10.8	1	2.4	-	--	-	--	12	2.3
4	-	--	-	--	1	2.0	-	--	3	.6
5	1	2.7	-	--	2	4.1	16	4.5	69	13.1
6	-	--	-	--	2	4.1	11	3.1	4	.8
7	-	--	-	--	-	--	6	1.7	10	1.9
9	19	51.4	15	36.6	13	26.5	17	4.8	44	8.3
10	2	5.4	-	--	1	2.0	1	.3	-	--
11	-	--	-	--	3	6.1	1	.3	4	.8
12	-	--	-	--	-	--	1	.3	1	.2
13	3	8.1	5	12.2	2	4.1	4	1.1	2	.4
14	-	--	-	--	-	--	2	.6	-	--
15	-	--	8	19.5	5	10.2	17	4.8	39	7.4
17	-	--	-	--	-	--	10	2.8	9	1.7
18	-	--	-	--	-	--	4	1.1	-	--
19	-	--	2	4.9	2	4.1	8	2.3	2	.4
20	-	--	-	--	-	--	14	4.0	-	--
21	-	--	-	--	-	--	5	1.4	2	.4
28	-	--	-	--	4	8.2	13	3.7	22	4.2
29	-	--	-	--	-	--	1	.3	-	--
31	2	5.4	4	9.8	1	2.0	11	3.1	9	1.7
32	3	8.1	-	--	-	--	-	--	-	--
33	1	2.7	-	--	1	2.0	5	1.4	7	1.3
34	1	2.7	-	--	-	--	-	--	-	--
35	-	--	-	--	-	--	33	9.3	32	6.1
37	-	--	1	2.4	1	2.0	4	1.1	17	3.2
40	-	--	-	--	-	--	1	.3	6	1.1
42	-	--	-	--	-	--	1	.3	-	--
43	-	--	-	--	-	--	1	.3	-	--
44	-	--	1	2.4	1	2.0	5	1.4	8	1.5
46	-	--	-	--	1	2.0	-	--	-	--
49	-	--	-	--	-	--	35	9.9	2	.4
50	-	--	2	4.9	1	2.0	1	.3	11	2.1
52	1	2.7	-	--	-	--	12	3.4	22	4.2
56	-	--	-	--	-	--	2	.6	-	--
58	-	--	-	--	1	2.0	-	--	2	.4
60	-	--	-	--	1	2.0	-	--	-	--
61	-	--	-	--	-	--	3	.8	-	--
64	-	--	-	--	1	2.0	4	1.1	2	.4
77	-	--	-	--	-	--	12	3.4	12	2.3
80	-	--	-	--	-	--	1	.3	-	--
90	-	--	-	--	1	2.0	1	.3	1	.2
91	-	--	-	--	-	--	4	1.1	6	1.1
93	-	--	-	--	2	4.1	-	--	8	1.5
105	-	--	-	--	2	4.1	6	1.7	4	.8
126	-	--	-	--	-	--	15	4.2	74	14.0
128	-	--	-	--	-	--	52	14.7	53	10.1
Isolates	37	100.0	41	100.0	49	99.6	354	100.0	527	100.2
Races	10		10		22		40		34	

collections obtained during 1925-1949.

Physiologic races identified	Total number of isolates	Percent of grand total	Periodic and geographic distribution of physiologic races identified: Individual States: Minnesota		Montana		North Dakota		South Dakota	
			No.	%	No.	%	No.	%	No.	%
1	29	2.9	15	2.5	6	18.8	4	1.5	4	3.7
2	15	1.5	4	.7	-	--	4	1.5	7	6.5
3	17	1.7	11	1.8	-	--	5	1.8	1	.9
4	4	.4	3	.5	1	3.1	-	--	-	--
5	88	8.7	56	9.4	2	6.2	25	9.2	5	4.7
6	17	1.7	13	2.2	-	--	3	1.1	1	.9
7	16	1.6	9	1.5	3	9.4	4	1.5	-	--
9	108	10.7	39	6.5	6	18.8	44	16.2	19	17.8
10	4	.4	1	.2	-	--	2	.7	1	.9
11	8	.8	4	.7	-	--	4	1.5	-	--
12	2	.2	1	.2	-	--	1	.4	-	--
13	16	1.6	6	1.0	3	9.4	7	2.6	-	--
14	2	.2	2	.3	-	--	-	--	-	--
15	69	6.8	34	5.7	2	6.2	27	9.9	6	5.6
17	19	1.9	12	2.0	1	3.1	4	1.5	2	1.9
18	4	.4	4	.7	-	--	-	--	-	--
19	14	1.4	5	.8	-	--	7	2.6	2	1.9
20	14	1.4	11	1.8	-	--	3	1.1	-	--
21	7	.7	2	.3	-	--	2	.7	3	2.8
28	39	3.9	30	5.0	-	--	4	1.5	5	4.7
29	1	.1	1	.2	-	--	-	--	-	--
31	27	2.7	11	1.8	2	6.2	8	2.9	6	5.6
32	3	.3	-	--	-	--	1	.4	2	1.9
33	14	1.4	4	.7	2	6.2	5	1.8	3	2.8
34	1	.1	-	--	-	--	1	.4	-	--
35	65	6.4	52	8.7	-	--	10	3.7	3	2.8
37	23	2.3	4	.7	-	--	14	5.1	5	4.7
40	7	.7	5	.8	-	--	1	.4	1	.9
42	1	.1	1	.2	-	--	-	--	-	--
43	1	.1	1	.2	-	--	-	--	-	--
44	15	1.5	5	.8	-	--	9	3.3	1	.9
46	1	.1	-	--	-	--	1	.4	-	--
49	37	3.7	35	5.9	-	--	2	.7	-	--
50	15	1.5	4	.7	1	3.1	10	3.7	-	--
52	35	3.5	24	4.0	-	--	8	2.9	3	2.8
56	2	.2	2	.3	-	--	-	--	-	--
58	3	.3	3	.5	-	--	-	--	-	--
60	1	.1	1	.2	-	--	-	--	-	--
61	3	.3	2	.3	-	--	-	--	1	.9
64	7	.7	3	.5	-	--	3	1.1	1	.9
77	24	2.4	21	3.5	-	--	3	1.1	-	--
80	1	.1	-	--	-	--	-	--	1	.9
90	3	.3	2	.3	-	--	1	.4	-	--
91	10	1.0	8	1.3	-	--	1	.4	1	.9
93	10	1.0	7	1.2	1	3.1	1	.4	1	.9
105	12	1.2	6	1.0	-	--	5	1.8	1	.9
126	89	8.8	59	9.9	-	--	18	6.6	12	11.2
128	105	10.4	74	12.4	2	6.2	20	7.4	9	8.4
Isolates	1008		597	59.2	32	3.2	272	27.0	107	10.6
Races	48		44		13		37		28	

cent), and race 5 (9.4 percent). The three most common among the 37 North Dakota races were race 9 (16.2 percent), race 15 (9.9 percent), and race 5 (9.2 percent). The three most common among the 28 South Dakota races were race 9 (17.8 percent), race 126 (11.2 percent), and race 128 (8.4 percent). Outstanding among the 13 Montana races were races 1 and 9, each constituting 18.8 percent of the State's total.

SEEDLING REACTION TO DIFFERENT PHYSIOLOGIC RACES OF WHEAT LEAF RUST

Some 200 standard varieties, hybrid selections, and foreign introductions of common wheats, durums, emmers, and einkorn were tested in the seedling stage under greenhouse conditions for their reaction to different physiologic races of leaf rust during the 12-year period, 1939-1950. The preponderant majority of races used had been isolated from collections made in the Upper Midwest area. Table 2 contains the reaction record of 113 lines, none of which had been subjected to fewer than 7 physiologic races, while several of them were tested with as many as 52 different races. All of the 48 Upper Midwest races were used in the test at one time or another. Many of the lines studied were tested to more than a single strain of a given race but, for the most part, the reaction was similar, if not altogether identical. The deviations will be pointed out later. In Table 2, the dominant reaction was recorded as either resistant or susceptible. The infection types, recorded in the original readings, were segregated into the two reaction classes in the following manner: (a) the infection types 0, 1, and 2 were incorporated into the resistant class, in which case 0 = practical immunity (no visible uredia, necrotic lesions or flecks often present), 1 = extreme resistance (minute uredia clearly visible, pustules embedded in well defined necrotic areas), 2 = moderate resistance (small uredia in abundance, necrotic lesions clearly defined but less extensive); (b) the infection types X, 3, and 4 were embodied in the susceptible class, in which case X = variable mesothesis (conglomeration of uredia of diverse size and type tending to integrate), 3 = moderate susceptibility (uredia of medium size, slight chlorosis usually accompanying infection centers), 4 = extreme susceptibility (predominantly large uredia, chlorosis rare, necrosis absent).

Among the 52 leaf rust races, used in the seedling reaction study, were eight races that consisted of more than one biotype. These were races: 1, 5, 9, 11, 15, 28, 93, and 126. Indistinguishable in their parasitic behavior on the customary differential hosts, the biotypes of each of the aforementioned races could be distinguished readily by the difference in type of infection produced on one or more additional wheat varieties as specified below. Thus, Frontana, ordinarily highly resistant to race 1, was moderately susceptible to a strain of race 1 in 1946. Most frequently, Cadet, Centenario, Kubanka, Pilot, Red Egyptian, Regent, Renown, and Rival are very resistant to race 5, but, occasionally, a biotype of race 5 produces normal infection on all of these varieties. Cincana, Maroqanith, and Pentad are resistant to some biotypes of race 5 as often as they are susceptible to other biotypes of this race. Khapli, on the other hand, usually susceptible to race 5, is resistant to an occasional strain of this race. Frontana and Red Egyptian most often are very resistant to race 9, but an occasional strain of this race attacks these two varieties rather severely. Just the opposite is true of Premier. As a rule, Lee, Frontana, Gaza, and Premier are highly resistant to race 11, but at least one strain of race 11 produces moderate to severe infections on these four varieties. In most trials, Frontana, Red Egyptian, and Regent are quite resistant to race 15, and only occasionally does a biotype of this race produce normal infection. The reverse is true of Premier. Hope, Kubanka, and Pentad are most often quite susceptible to race 28, but an occasional biotype of this race is incapable of producing normal infection on these three varieties. Usually Frontana is very resistant, while Merit 3 and Premier are very susceptible to race 93; but the reverse is true on rare occasions. In the tests made during 1945, 1947, and 1948, Cadet invariably was highly susceptible to race 126, but a biotype of this race, used in 1946, failed to produce normal infection on seedlings of Cadet.

Mindful of the existence of biotypes among certain, or all, physiologic races and of their infrequent detection, a single seedling test cannot be considered an infallible indication of the varietal reaction to any specific leaf rust race. Consequently, more than one isolate of any given physiologic race should be used if the results obtained are expected to be reliable or significant.

Table 2. Seedling reaction to physiologic races of Puccinia rubigo-vera tritici of different varieties of wheat tested under greenhouse conditions.

Varieties tested		Reaction to specified races	
Name	C. I. No.	Resistant	Susceptible
Acme	5284	9, 10, 15, 31, 52, 77	1, 2, 3, 5, 7, 11, 12, 13, 14, 16, 17, 18, 20, 21, 28, 35, 49, 58, 90, 93, 126, 128
American Banner	6943		1, 2, 5, 9, 11, 12, 15, 21, 28, 31, 35, 52, 77, 91, 93, 126, 128
Aniversario	12578	3, 5, 9, 14, 16, 58, 90, 93, 126, 128	12
Apulia x Progreso	12587	1, 2, 3, 5, 9, 11, 12, 14, 15, 16, 21, 28, 31, 35, 43, 52, 58, 90, 93, 107, 126, 128	
Arnautka	1493	1, 2, 3, 5, 7, 9, 10, 11, 13, 15, 16, 17, 18, 20, 21, 28, 31, 35, 49, 52, 58, 77, 90, 93, 126, 128	12, 14
Australith	12808	21, 28	2, 3, 5, 7, 9, 11, 12, 14, 15, 16, 31, 35, 58, 90, 93, 126, 128
Baart-1121 x 1581 (N.No. 1919)	12877	1, 2, 7, 15	10, 17, 18, 31, 35, 49, 52, 77, 126, 128
Bahiense (N.S.No. [a] (III-46-16)	12591	28, 93	2, 3, 5, 7, 9, 11, 12, 13, 14, 15, 16, 31, 35, 58, 90, 126, 128
Baldrock	11538		1, 2, 5, 9, 11, 12, 15, 21, 28, 31, 35, 52, 77, 91, 93, 126, 128
Benvenuto-Inca	12588	1, 5, 11, 28	9, 12, 15, 21, 31, 35, 52, 93, 126, 128
Benvenuto Pampa	12809	1, 5, 9, 11, 28	12, 15, 21, 31, 35, 52, 93, 126, 128
Blue Jacket	12502		2, 3, 5, 9, 11, 12, 14, 15, 16, 58, 90, 93, 126, 128
Brevit	3778	1, 2, 3, 5, 7, 9, 13, 15, 16, 17, 18, 19, 21, 28, 31, 33, 34, 35, 37, 40, 44, 46, 52, 60, 90, 93, 126, 128	4, 6, 8, 10, 11, 12, 14, 20, 26, 29, 32, 42, 43, 49, 50, 56, 58, 61, 64, 77, 80, 91, 105, 107

[a]Minnesota Nursery stock number.

Table 2, (Continued)

Varieties tested		Reaction to specified races	
Name	C.I. No.	Resistant	Susceptible
Buck-Quequen	12574		1, 5, 9, 11, 12, 15, 21, 28, 31, 35, 52, 93, 126, 128
Cadet	12053	1, 2, 3, 5, 7, 9, 11, 15, 20, 26, 28	10, 12, 13, 14, 16, 17, 18, 21, 29, 31, 33, 35, 49, 52, 58, 61, 77, 90, 93, 107, 126, 128
Capelli	12452	1, 2, 3, 5, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 21, 28, 31, 35, 43, 49, 52, 58, 77, 90, 93, 107, 126, 128	
Carina	3756	1, 2, 3, 5, 6, 7, 8, 9, 11, 14, 15, 16, 17, 28, 31, 32, 33, 34, 35, 37, 44, 50, 52, 58, 60, 61, 64, 90, 93, 105, 126, 128	4, 10, 12, 13, 18, 19, 20, 21, 26, 29, 40, 42, 43, 46, 49, 56, 77, 80, 91, 107
Carleton	12064	1, 2, 3, 5, 7, 9, 10, 11, 13, 14, 15, 16, 17, 18, 20, 21, 28, 31, 33, 35, 49, 52, 77, 90, 93, 126	12, 58, 61, 107, 128
Centenario	12021	1, 2, 3, 5, 9, 11, 12, 14, 15, 16, 20, 26, 28, 31, 33, 49, 58, 61, 107, 126	7, 21, 35, 52, 90, 93, 128
Ceres	6900		1, 2, 5, 9, 15, 20, 31, 33, 49
Ceres x Hope-Florence	11640		1, 2, 5, 9, 15, 31, 33
Ceres x Hope-Florence	11714		1, 2, 5, 9, 15, 31, 33
Cincana (N.S.No. III-47-19)	12810	2, 5, 11, 13, 28, 90, 93	3, 7, 9, 12, 14, 15, 16, 31, 35, 58, 126, 128
Democrat	3384	1, 4, 8, 9, 10, 11, 13, 14, 16, 17, 18, 19, 20, 26, 29, 31, 37, 43, 49, 50, 56, 64, 91, 93, 107, 128	2, 3, 5, 6, 7, 12, 15, 21, 28 32, 33, 34, 35, 40, 42, 44, 46, 52, 58, 60, 61, 77, 80, 90, 105, 126
Einkorn	2433	1, 2, 5, 6, 8, 9, 12, 13, 14, 15, 16, 20, 21, 31, 33, 35, 43, 44, 49, 50, 52, 60, 64, 90, 93, 126, 128	11, 28,
Esteana (N.S.No. III-46-12)	12811	9, 11, 13, 14, 16, 28, 31, 93, 128	2, 3, 5, 7, 12, 15, 35, 58, 90, 126
Eureka (N.S.No. III-46-15) (from Argentina)	12812	93	2, 3, 5, 7, 9, 11, 12, 13, 14 15, 16, 28, 31, 35, 58, 90, 126, 128
Exchange	12635	1, 2, 3, 4, 5, 7, 9, 11, 12,	

Table 2. (Continued)

Varieties tested		Reaction to specified races	
Name	C.I. No.	Resistant	Susceptible
Exchange (Continued)		14, 15, 16, 17, 19, 21, 28, 31, 33, 35, 37, 40, 43, 52, 58, 77, 90, 91, 93, 105, 107, 126, 128	
Frondoso	12078	1, 2, 5, 6, 11, 17, 31, 40, 50, 64, 91	9, 12, 15, 21, 28, 35, 49, 52, 77, 93, 126, 128
Frondoso x Chinese Progress (N.S.No. III-46-14)	12813	2, 5, 11, 14, 15, 93	3, 9, 12, 13, 16, 21, 28, 31, 35, 58, 90, 126, 128
(N.S.No. III-46-15)	12814	11, 12, 14, 21, 58, 93, 126, 128	2, 3, 5, 7, 9, 13, 15, 16, 28, 31, 35, 90
(N.S.No. III-46-16)	12815	11, 21, 93	2, 3, 5, 7, 9, 12, 13, 14, 15, 16, 28, 31, 35, 58, 90, 126, 128
Frontana	12470	1, 2, 3, 4, 5, 7, 9, 11, 12, 13, 14, 15, 16, 17, 19, 21, 28, 31, 33, 35, 37, 40, 43, 52, 58, 77, 90, 91, 93, 105, 126, 128	107
Fronteira	12019	93	1, 2, 3, 5, 7, 9, 11, 12, 14, 15, 16, 17, 21, 28, 31, 35, 52, 58, 90, 126, 128
Gabo	12795	1, 3, 4, 5, 7, 9, 15, 17, 19, 28, 31, 33, 35, 37, 40, 52, 58, 77, 91, 105, 126	
Gaza	12616	1, 2, 3, 5, 9, 13, 14, 15, 16, 21, 58, 90, 93, 126, 128	12, 28, 31, 35, 52
H-44	8177		1, 2, 5, 9, 15, 31, 33
Haynes Bluestem	2874	1, 5, 11, 15, 28, 52, 126, 128	9, 12, 21, 31, 35, 93
Henry	12265	1, 2, 3, 5, 7, 9, 10, 11, 12, 14, 15, 16, 20, 21, 26, 28, 33, 43, 49, 58, 61, 90, 91, 107, 126	17, 18, 31, 35, 52, 77, 93, 128
Hood	11456		2, 5, 6, 8, 9, 11, 13, 14, 15, 16, 20, 28, 31, 43, 44, 50, 60, 64, 90, 93
Hope	8178	3, 11, 12, 13, 35, 44, 52, 58, 64, 93	1, 2, 5, 6, 7, 8, 9, 14, 15, 16, 20, 21, 28, 31, 33, 43, 50, 60, 90, 126, 128
Hussar	4843	1, 3, 4, 5, 7, 8, 9, 10, 11, 15, 16, 19, 32, 33, 35, 37, 43, 44, 46, 50, 58, 90, 93, 105, 126	2, 6, 12, 13, 14, 17, 18, 20, 21, 28, 29, 31, 34, 40, 42, 49, 52, 56, 60, 61, 64, 77, 80, 91, 107, 128

Table 2. (Continued)

Varieties tested		Reaction to specified races	
Name	C.I. No.	Resistant	Susceptible
(Ill. No. 1-Chinese)^2 x Timopheevi (Wis. 245)	12633	9, 11, 12, 14, 15, 16, 58, 126	2, 3, 5, 90, 93, 128
Jenkin	5177		1, 2, 5, 9, 15, 31, 33
Kenya 58	12471		2, 3, 5, 9, 11, 12, 14, 15, 16, 58, 90, 93, 126, 128
Kenya 117-A	12568		2, 3, 5, 9, 11, 12, 14, 15, 16, 58, 90, 93, 126, 128
Khapli	4013	1, 2, 11, 15, 16, 28, 52, 58, 90, 93, 126, 128	3, 5, 9, 12, 14, 20, 21, 31, 35, 49, 61
Klein 66	12091		1, 5, 9, 11, 12, 15, 21, 28 31, 35, 52, 93, 126, 128
Klein 157	12586	1, 9, 11, 28, 31, 128	5, 12, 15, 21, 35, 52, 93, 126
Klein-Amalia	12577	1, 2, 3, 5, 11, 12, 14, 15, 16, 58, 93	9, 13, 21, 28, 31, 35, 52, 90, 126, 128
Klein-Exito	12581	1, 11	5, 9, 12, 15, 21, 28, 31, 35, 52, 93, 126, 128
Klein-Otto Wulff	12583	1, 11, 28	5, 9, 12, 15, 21, 31, 35, 52, 93, 126, 128
Klein-Sinmarq	12584	1, 11, 28	5, 9, 12, 15, 21, 31, 35, 52, 93, 126, 128
Klein Titan	12615	1, 3, 4, 5, 7, 9, 15, 17, 19, 28, 31, 33, 35, 37, 40, 52, 58, 77, 91, 105, 126	
Kota	5878		1, 2, 3, 5, 7, 9, 11, 12, 13, 14, 15, 16, 20, 21, 28, 31, 35, 49, 52, 58, 90, 93, 126, 128
Kubanka	1440	2, 3, 5, 9, 10, 11, 13, 14, 18, 31, 33, 52, 126, 128	1, 7, 12, 15, 16, 17, 20, 21, 28, 35, 49, 58, 77, 90, 93
Lageadinho (N.S.No. III-47-18)	12816	13, 15, 28, 31, 35	2, 3, 5, 7, 9, 11, 12, 14, 16, 58, 90, 93, 126, 128
La Prevision 25	12596	1, 2, 3, 4, 5, 7, 9, 11, 12, 14, 15, 16, 17, 19, 21, 28, 31, 33, 35, 37, 40, 43, 52, 58, 77, 90, 91, 93, 105, 107, 126, 128	
Lee	12488	1, 2, 3, 4, 5, 6, 7, 9, 11, 13, 14, 15, 16, 17, 19, 21, 28, 31, 33, 35, 37, 40, 43, 49,	12

Table 2. (Continued)

Varieties tested		Reaction to specified races	
Name	C.I. No.	Resistant	Susceptible
Lee (Continued)		50, 52, 58, 64, 77, 90, 91, 93, 105, 107, 126, 128	
Little Club	4066		2, 5, 9, 12, 15, 20, 28, 33, 49, 52, 61, 107, 128
Loros	3779	1, 2, 5, 7, 15, 16, 17, 34, 52, 56, 60, 91, 93	3, 4, 6, 8, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 28, 29, 31, 32, 33, 35, 37, 40, 42, 43, 44, 46, 49, 50, 58, 61, 64, 77, 80, 90, 105, 107, 126, 128
M. A. 38 (N.S.No. III-46-2)	12597	2, 5, 15	3, 9, 11, 12, 13, 14, 16, 21, 28, 31, 35, 58, 90, 93, 126, 128
Malakof	4898	1, 2, 3, 4, 11, 12, 14, 15, 16, 18, 32, 33, 34, 44, 46, 56, 58, 61, 90, 107	5, 6, 7, 8, 9, 10, 13, 17, 19, 20, 21, 28, 29, 31, 35, 37, 40, 42, 43, 49, 50, 52, 60, 64, 77, 80, 91, 93, 105, 126, 128
Maroqanith	12817	5, 7, 13, 21, 35	2, 3, 9, 11, 12, 14, 15, 16, 28, 31, 58, 90, 93, 126, 128
Marquis	3641		1, 2, 3, 5, 7, 9, 11, 12, 13, 14, 15, 16, 21, 28, 31, 33, 35, 52, 58, 90, 93, 126, 128
McMurachy-Exchange x Redman (R.L. 2325) (N.S.No. III-46-17)	12832	1, 2, 3, 5, 7, 9, 11, 12, 13, 14, 15, 16, 21, 28, 31, 35, 43, 52, 58, 90, 93, 107, 126, 128	
McMurachy-Exchange x Redman (R.L. 2327)	12833	1, 5, 9, 11, 12, 15, 16, 21, 28, 31, 35, 43, 52, 93, 107, 126, 128	
Mediterranean	3332	1, 9, 10, 11, 13, 14, 16, 17, 18, 19, 20, 26, 29, 31, 33, 37, 43, 46, 49, 50, 64, 91, 93, 107, 128	2, 3, 4, 5, 6, 7, 8, 12, 15, 21, 28, 32, 34, 35, 40, 42, 44, 52, 56, 58, 60, 61, 77, 80, 90, 105, 126
Merit 3	12036	1, 2, 5, 7, 9, 11, 15, 20, 26, 28, 58, 90	3, 10, 12, 13, 14, 16, 18, 21, 31, 35, 49, 52, 61, 77, 93, 107, 126, 128
Mida	12008	1, 2, 5, 6, 7, 9, 11, 12, 15, 16, 20, 26, 28, 40, 50, 58, 64, 90, 91, 126	3, 10, 13, 14, 17, 18, 21, 31, 33, 35, 49, 52, 61, 77, 93, 107, 128
Mindum	5296	1, 2, 5, 7, 9, 10, 11, 13, 15, 16, 17, 18, 20, 21, 26, 28,	3, 12, 14, 61, 90, 107, 128

Table 2. (Continued)

Varieties tested		Reaction to specified races	
Name	C. I. No.	Resistant	Susceptible
Mindum (Continued)		31, 33, 35, 49, 52, 58, 77, 93, 126	
Newthatch	12318	1, 2, 5, 9, 11, 15, 20, 26, 28, 43, 58, 91	3, 7, 10, 12, 13, 14, 16, 17, 18, 21, 31, 33, 35, 49, 52, 61, 77, 90, 93, 107, 126, 128
Nursith	12818	2, 9, 13, 21, 28, 90, 93, 126, 128	3, 5, 11, 12, 14, 15, 31, 35, 58
Pelon Plateado	12819	1, 9, 11, 15, 28	5, 12, 21, 31, 35, 52, 93, 126, 128
Pentad	3320	5, 9, 21, 52, 126	1, 2, 3, 7, 11, 12, 14, 15, 28, 31, 35, 58, 90, 93, 128
Petiso	12820	1, 5, 9, 11, 15, 28	12, 21, 31, 35, 52, 93, 126, 128
Pilot	11945	1, 2, 3, 5, 6, 7, 9, 11, 15, 20, 26, 28, 40, 50, 58, 64, 90, 91	10, 12, 14, 16, 17, 18, 21, 31, 33, 35, 49, 52, 61, 77, 93, 107, 126, 128
Pilot x 1514	12476	1, 2, 5, 6, 11, 17, 31, 40, 50, 91	15, 35, 49, 64, 77, 128
Premier	11940	1, 2, 3, 12, 16, 31, 58, 90	5, 9, 11, 14, 15, 21, 28, 35, 52, 93, 126, 128
Premier x Bobin 2-Gaza (N.S.No. II-39-2)	12821	1, 2, 3, 5, 6, 7, 9, 11, 12, 13, 14, 15, 16, 17, 21, 28, 31, 35, 40, 43, 49, 50, 52, 58, 64, 77, 90, 91, 93, 107, 126, 128	
Quanah	12145	11	5, 9, 15, 52, 126
Red Egyptian	12345	1, 2, 5, 9, 11, 15, 20, 26, 28, 90,	3, 12, 14, 16, 21, 31, 33, 35, 43, 49, 52, 58, 61, 77, 93, 107, 126, 128
Regent	12070	1, 2, 3, 5, 7, 9, 11, 15, 20, 26, 28	10, 12, 14, 16, 17, 18, 21, 31, 33, 35, 49, 52, 58, 61, 77, 90, 93, 107, 126, 128
Reliance	7370		1, 2, 3, 5, 9, 11, 12, 14, 15, 16, 20, 21, 28, 31, 35, 49, 52, 58, 90, 93, 126, 128
Reliance-Hope x Pilot	12366	1, 2, 7, 15	10, 17, 18, 31, 35, 49, 52, 64, 126, 128
Reliance x R.L. 729-R. L. 2088 (N.S. No. III-47-36)	12822	2, 16, 21, 93, 128	3, 5, 9, 11, 12, 13, 14, 15, 28, 31, 35, 58, 90, 126

Table 2. (Continued)

Varieties tested		Reaction to specified races	
Name	C.I. No.	Resistant	Susceptible
Renown	11947	1, 2, 3, 5, 7, 9, 11, 15, 20, 28, 58, 90	10, 12, 14, 16, 17, 18, 21, 31, 33, 35, 49, 52, 61, 77, 93, 107, 126, 128
Reward	8182		1, 2, 5, 9, 15, 20, 31, 33, 49
Rio Negro	12469	1, 3, 5, 15, 17, 19, 28, 31, 35, 40, 52, 91	4, 7, 9, 33, 77, 126
Rival	11708	1, 2, 3, 5, 9, 11, 15, 20, 28, 58, 90	10, 12, 14, 16, 17, 18, 21, 31, 33, 35, 49, 52, 61, 93, 107, 126, 128
Saunders	12567	3, 15, 21, 28, 31, 35, 58, 90	2, 5, 9, 11, 12, 14, 16, 93, 126, 128
Sinvalocho	12595	1, 9, 28	5, 11, 12, 15, 21, 31, 35, 52, 93, 126, 128
Spelmar	6236	1, 2, 5, 7, 9, 11, 13, 14, 15, 16, 17, 18, 20, 21, 28, 31, 35, 52, 58, 77, 90, 93, 126, 128	3, 12, 49
Spinkcota	12499	1, 11, 15, 17, 31	2, 5, 6, 35, 40, 49, 50, 64, 77, 91, 128
Stewart	12066	2, 5, 10, 13, 20, 26, 28, 31	1, 3, 7, 9, 11, 12, 14, 15, 16, 17, 18, 21, 33, 35, 49, 52, 58, 61, 77, 90, 93, 107, 126, 128
Surpresa	12474	1, 2, 3, 5, 6, 9, 11, 14, 15, 16, 31, 40, 50, 58, 64, 90, 91, 93	12, 21, 28, 35, 52, 77, 126, 128
Thatcher	10003	44	1, 2, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 20, 21, 26, 28, 31, 33, 35, 40, 43, 49, 50, 52, 60, 61, 64, 77, 90, 91, 93, 107, 126, 128
Thew	5002	1, 58, 91	2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 26, 28, 31, 33, 35, 37, 40, 43, 44, 49, 50, 52, 60, 61, 64, 77, 90, 93, 105, 107, 126, 128
Timopheevi	11802	1, 2, 5, 9, 11, 12, 14, 15, 16, 20, 21, 26, 28, 31, 33, 35, 43, 49, 52, 58, 61, 90, 93, 107, 126, 128	

Table 2. (Concluded)

Varieties tested		Reaction to specified races	
Name	C.I. No.	Resistant	Susceptible
Timstein	12347	1, 2, 3, 5, 9, 11, 14, 15, 16, 20, 21, 26, 28, 33, 35, 52, 58, 90, 93, 126, 128	12, 31, 49, 61, 107
Timstein x Newthatch	12634	1, 2, 3, 5, 7, 9, 11, 12, 13, 14, 15, 16, 21, 28, 31, 35, 43, 52, 58, 90, 93, 107, 126, 128	
Trintecinco x Litoral (N.S.No. III-46-3)	12823	7, 13, 31,	2, 3, 5, 9, 11, 12, 14, 15, 16, 21, 28, 33, 35, 58, 90, 93, 126, 128
Triumph	12132		2, 3, 5, 9, 11, 12, 14, 15, 16, 58, 90, 93, 126, 128
Uruguay 2762/562003	12824	5, 9, 11, 15, 28, 31	1, 12, 21, 35, 52, 93, 126, 128
Uruguay 2762/5637	12825	5, 9, 11, 15, 28, 31	1, 12, 21, 35, 52, 93, 126, 128
Vernal	3686	1, 11, 28, 52	2, 3, 5, 9, 12, 14, 15, 16, 20, 21, 31, 35, 49, 58, 90, 93, 126, 128
Vernum	12255	2, 3, 5, 9, 11, 15, 90, 93 126, 128	12, 14, 58
Wabash x American Banner--outcross	12878	2, 3, 5, 9, 11, 12, 14, 15, 16, 43, 58, 90, 93, 107, 126, 128	
Warden x Leap	12660	2, 3, 5, 9, 11, 12, 14, 15, 16, 58, 90, 93, 107, 126, 128	43
Warden x Purkof	12879	2, 3, 5, 9, 11, 12, 14, 15, 16, 43, 58, 90, 93, 107, 126, 128	
Webster	3780	1, 2, 3, 4, 5, 6, 11, 12, 14, 15, 16, 17, 26, 28, 32, 33, 34, 37, 40, 43, 44, 46, 49, 50, 52, 56, 58, 61, 64, 93, 105, 126, 128	7, 8, 9, 10, 13, 18, 19, 20, 21, 29, 31, 35, 42, 60, 77, 80, 90, 91, 107
Yorkwin	11855		1, 2, 5, 9, 11, 12, 15, 21, 28, 31, 35, 52, 77, 91, 93, 126, 128

Table 3. Comparative reaction to leaf rust of wheat and durum varieties grown in field plots at University Farm, St. Paul, Minnesota.

Varieties tested		Percentage of infection in any given year									
Name	C.I. No.	1947	1946	1945	1944	1943	1942	1941	1940	1939	1938
Acme	5284	--	--	5	0	0	2	2	T	0	0
Arnautka	1493	T	T	5	15	0	T	T	1	0	--
Bahiense (N.S. No. III-46-16)	12591	10	--	--	--	--	--	--	--	--	--
Benvenuto-Inca	12588	10	--	--	10	10	--	--	--	--	--
Brevit	3778	--	--	90	--	--	--	--	--	--	--
Buck-Quequen	12574	T	--	--	10	5	--	--	--	--	--
Cadet	12053	40	50	65	60	T	5	1	--	--	--
Carina	3756	--	15	70	--	--	--	--	--	--	35
Carleton	12064	T	T	5	10	T	T	T	--	--	--
Cincana (N.S. No. III-47-19)	12810	10	10	--	--	--	--	--	--	--	--
Ceres	6900	80	50	70	100	50	60	40	60	75	80
Esteana (N.S. No. III-46-12)	12811	T	T	--	--	--	--	--	--	--	--
Eureka (N.S. No. III-46-15)	12812	60	--	--	--	60	--	--	--	--	--
Frondoso	12078	--	--	--	--	T	--	--	--	--	--
Frondoso x Chinese Progress (N.S. No. III-46-14)	12813	T	5	--	--	--	--	--	--	--	--
(N.S. No. III-46-15)	12814	10	5	--	--	--	--	--	--	--	--
(N.S. No. III-46-16)	12815	T	5	--	--	--	--	--	--	--	--
Frontana	12470	T	0	--	--	--	--	--	--	--	--
Fronteira	12019	--	0	20	--	T	--	--	--	--	--
H-44	8177	--	--	80	--	T	--	--	--	--	--
Haynes Bluestem	2874	60	50	80	80	35	42	50	25	80	80
Henry	12265	35	25	75	25	T	T	--	--	--	--
Hope	8178	50	50	80	50	T	T	T	T	T	T
Kenya 58	12471	--	80	50	57	--	--	--	--	--	--
Kenya 117A	12568	--	80	50	57	--	--	--	--	--	--
Klein 66	12091	--	--	--	10	T	--	--	--	--	--
Klein 157	12586	15	--	--	10	35	--	--	--	--	--
Klein-Amalia	12577	10	--	--	30	T	--	--	--	--	--
Klein-Exito	12581	10	--	--	70	10	--	--	--	--	--
Klein-Otto Wulff	12583	T	--	--	10	10	--	T	--	T	--
Klein-Sinmarq	12584	10	--	--	55	15	--	--	--	--	--
Klein Titan	12615	T	--	--	--	--	--	--	--	--	--
Kota	5878	75	75	70	95	50	95	95	100	65	75
Kubanka	1440	T	--	15	5	T	2	3	1	T	0
Lageadinho (N.S. No. III-47-18)	12816	T	--	--	--	--	--	--	--	--	--
La Prevision 25	12596	T	--	--	10	5	--	--	--	--	--
Lee	12488	T	16	35	--	--	--	--	--	--	--
Loros	3779	--	--	80	100	90	95	10	100	65	80
M. A. - 38 (N.S. No. III-46-2)	12597	10	T	--	--	--	--	--	--	--	--
Marquis	3641	85	60	60	90	60	50	60	80	80	80
McMurachy-Exchange x Redman (R.L. 2325)	12832	T	--	--	--	--	--	--	--	--	--
Merit 3	12036	--	--	--	--	85	3	1	10	5	--
Merit x Pilot	12315	30	25	60	--	--	--	--	--	--	--
Mida	12008	50	40	70	45	T	T	T	2	--	--
Mida x Cadet	12363	30	25	--	--	--	--	--	--	--	--
Mindum	5296	T	T	5	5	T	T	T	T	0	1

Table 3. (Concluded)

Varieties tested		Percentage of infection in any given year									
Name	C.I. No.	1947	1946	1945	1944	1943	1942	1941	1940	1939	1938
Newthatch	12318	80	70	80	65	T	T	T	T	--	--
Pentad	3320	5	T	5	10	0	3	3	T	T	1
Pilot	11945	40	40	65	60	1	T	T	2	30	10
Pilot x Mida	12303	28	25	--	--	--	--	--	--	--	--
Premier	11940	60	60	75	--	5	--	T	1	T	--
Premier x Bobin 2-Gaza (N.S. No. II-39-2)	12821	10	--	75	--	--	--	--	--	--	--
Preston	3081	65	65	45	85	35	45	95	95	45	65
Red Egyptian	12345	--	--	30	10	--	15	--	--	--	--
Regent	12070	70	65	70	75	T	T	T	25	T	--
Reliance	7370	65	50	65	80	20	30	70	45	45	30
Renown	11947	--	--	--	--	T	T	15	20	10	--
Reward	8182	--	--	--	--	--	--	--	--	--	100
Rio Negro	12469	T	T	--	--	--	--	--	--	--	--
Rival	11708	50	40	65	60	20	10	T	10	25	--
Rival x Thatcher	12273	73	--	--	--	--	--	--	--	--	--
Saunders	12567	80	--	--	--	--	--	--	--	--	--
Sinvalocho	12595	T	T	--	10	5	--	--	--	--	--
Spelmar	6236	T	T	5	5	T	T	T	1	0	1
Spinkcota	12499	--	70	80	--	--	--	--	--	--	--
Stewart	12066	T	T	5	20	T	T	1	--	--	--
Surpresa	12474	--	T	15	--	T	--	--	T	T	T
Thatcher	10003	80	70	90	90	60	75	100	80	80	80
Thew	5002	--	--	--	95	--	--	--	--	--	--
Timstein	12347	T	5	50	10	T	T	--	--	--	--
Webster	3780	5	20	30	10	15	20	60	5	20	15

COMPARATIVE VARIETAL REACTION TO LEAF RUST UNDER FIELD CONDITIONS

A total of 71 varieties and selections of hybrids of common and durum wheat were tested at University Farm, St. Paul, for their reaction to leaf rust in the maturing stage. About four-fifths of these varieties were grown in field plots under artificially induced leaf rust epidemics, superimposed on natural infection. The remainder constituted part of the uniform rust observation nurseries grown each year and were dependent on natural leaf rust epidemics for infection. Rust readings on 10 of the lines listed in Table 3 were available only for a single year, but were recorded in each of the 10 years for 13 other lines. Most of the common and durum varieties tested in the adult stage, under field conditions, were also tested in the seedling stage, under greenhouse conditions. The rust infections in the field plots were recorded in percentage terms based on the modified Cobb scale, generally used by cereal rust workers.

A perusal of the data presented in Table 3 will reveal that a number of varieties considered to be highly resistant to leaf rust until 1944 have shown very little if any resistance since that date. Notable among these varieties are: Cadet, Hope, Mida, Newthatch, Pilot, Regent, and, to a certain extent, Rival and Henry. Something like this was foreseen, when one of the authors of this report expressed his misgivings at the Seventh Hard Spring Conference held at St. Paul and Minneapolis on February 28 and 29 - March 1, 1944, in the following words: "It would seem obvious from the above records, meager as they may be, that there is not as yet, and perhaps never can be, any absolute assurance that a wheat variety highly resistant to leaf rust under a certain set of conditions in any given area over a limited period of time will not eventually prove to be very susceptible." That this would happen so soon afterwards could not be foreseen.

Although the tendency in recent years is rather general for wheat varieties to become more severely attacked by leaf rust, certain durum varieties, including Acme, Kubanka, Mindum, and Spelmar, seem to be as resistant now under field conditions as they were 35 years ago. On

the other hand, varieties such as Haynes Bluestem, Kota, and Preston, despite the fact that they have been practically out of cultivation on farms for from 15 to 25 years, have consistently been the subjects of leaf rust epidemics in disease gardens and uniform nurseries for 30 years or more. Several spring wheats, principally Frontana, Klein Titan, Lee, and McMurachy - Exchange x Redman, which have proved to be highly resistant under greenhouse conditions to a great number of physiologic races in the seedling stage and in many field tests also in the maturing stage, are now being extensively used as parental material in the breeding programs pursued at Minnesota and elsewhere.

UNIVERSITY OF MINNESOTA AND U. S. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, DIVISION OF CEREAL CROPS AND DISEASES

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